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Katarzyna Budzynska, Mathilde Janier, Juyeon Kang, Barbara Konat, Chris Reed, Patrick Saint Dizier, Manfred Stede, Olena Yaskorska

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Automatically identifying transitions between locutions in dialogue

KATARZYNA BUDZYNSKA

*Institute of Philosophy and Sociology / Polish Academy of Sciences,
Poland and Centre for Argument Technology / University of Dundee,
UK*

k.budzynska@dundee.ac.uk

MATHILDE JANIER

Centre for Argument Technology / University of Dundee, UK

m.janier@dundee.ac.uk

JUYEON KANG

Prometil, France

j.kang@prometil.com

BARBARA KONAT

Centre for Argument Technology / University of Dundee, UK

bkonat@dundee.ac.uk

CHRIS REED

Centre for Argument Technology / University of Dundee, UK

c.a.reed@dundee.ac.uk

PATRICK SAINT-DIZIER

IRIT-CNRS, France

stdizier@irit.fr

MANFRED STEDE

*Applied CompLing Discourse Research Lab / University of Potsdam,
Germany*

stede@uni-potsdam.de

OLENA YASKORSKA

*Institute of Philosophy and Sociology / Polish Academy of Sciences,
Poland*

OYaskorska@gmail.com

The contribution of this paper is theoretical foundations for dialogical argument mining, as well as initial implementation in software for dialogue processing. Automatically identifying the structure of reasoning from natural language is extremely demanding. Our hypothesis is that the structure of dialogue can yield additional clues as to argument structures that are created and cocreated. Our work has been performed using the MM2012 corpus in OVA+.

KEYWORDS: argument mining, Inference Anchoring Theory, dialogue structure.

1. INTRODUCTION

Argumentative exchanges expressed through dialogical interaction can involve many more variables and subtleties than do arguments expressed as monologues. In trying to build algorithms that might automatically detect the presence and structure of argument, it might be expected that research should begin with the simpler monological cases before moving on to generalise techniques for dialogue. It turns out, however, that the very complexity that makes dialogue so challenging also offers rich sources of additional information that can be used to guide the automatic recognition process. This paper demonstrates how working with broadcast debate using a relatively new approach to the analysis of dialogical argumentation can offer insight into the dialogue games that participants are playing, and that those dialogue games give detailed grist to the algorithmic mill.

2. INFERENCE ANCHORING THEORY

Inference Anchoring Theory – IAT (Budzynska and Reed, 2011) provides the framework for connecting dialogical structures with argumentative structures thus allowing for the analysis of natural dialogical interactions. IAT is not a general-purpose discourse analysis technique. It is tailored specifically to handle discourse that involves argumentation, i.e., the giving of reasons in support of claims in order to affect an audience. Examples of such discourses are mediation (Janier et al., this issue) and debate (Janier and Yaskorska, this issue). Let us present the example of a simple dialogue:

- (1)
- a. Bob: *p* is the case
- b. Wilma: Why *p*?
- c. Bob: *q*

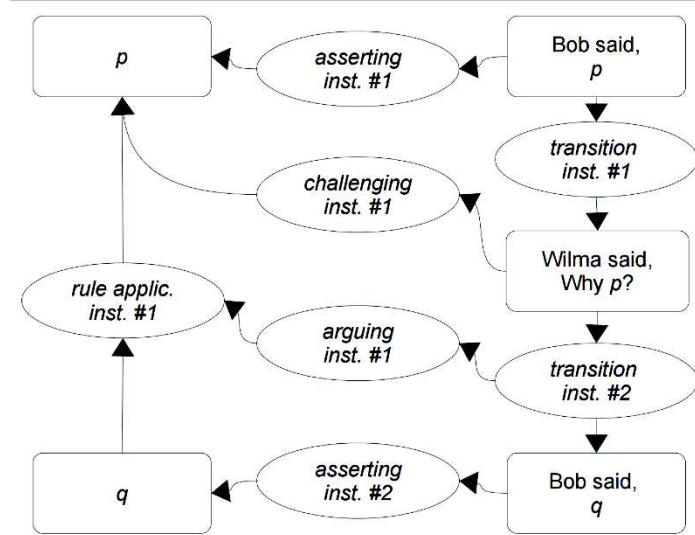


Figure 1. An IAT analysis of the dialogical and argumentative instances.

Figure 1 presents the diagram with IAT analysis of the dialogue from example (1). Right-hand side of the diagram consists of the propositional reports on locutions (such as “Bob said, p ” etc.). Left-hand side of the diagram consists of nodes with propositional content (in this case: p and q). Three different types of relation are expressed in figure 1:

- i) relations between locutions in dialogues (transition instance #1 and #2);
- ii) relations between propositions (rule application instance #1); and
- iii) illocutionary connections that link locutions with their contents (asserting instance #1 and #2, challenging instance #1, arguing instance #1).

The first type of relations refers to rules of protocol which speakers follow to perform locutions during a dialogue game. For example, locution (1-b) is a legal response to (1-a) which means that they are related via some specific protocol rule of the game. Application of those rules creates instances of transitions (transition instance #1 and #2). Relations of type (ii) are typically studied in logic and argumentation theory. In figure 1, we have only one relation of this type: that is relation of inference (rule application instance #1). However, IAT allows for expressing also other relations, such as conflict or rephrasing. Relations of type (iii) are illocutionary connections with which a given locution is performed. In this work, illocutionary connections are intuitively related to various illocutionary forces (i.e. the speaker’s communicative intentions (Searle, 1969)).

Representation of discourse structures involving argumentation requires some way of representing relations connecting those two elements. In IAT this is achieved by the concept of anchoring illocutionary connection. Two general types of anchoring are possible. Example of the first type, presented in the figure 1 is the challenging instance #1, as it is anchored in the propositional report on locution (on the right-hand side) and targets propositional content (on the left-hand side). Illocutionary connections anchored in transition and targeting rule application instances are the second type. In figure 1 an example of such a connection is arguing instance #1. Illocutionary connections anchored in transitions are the focus of this paper.

3. THEORETICAL FOUNDATIONS FOR MINING ARGUMENTS IN A DIALOGUE

The research presented in this paper aims to automatically extract inferential structures (arguments pro-) and conflict structures (argument con-) using as cues their dialogical context (see Budzynska et al 2014a; Budzynska et al 2014b). In order to efficiently recognise arguments in a dialogue, we need a solid theoretical foundations which will represent not only elements of arguments and elements of dialogue, but also explain how these two types of structures are connected with each other. Inference Anchoring Theory, described in the previous section, is a good candidate for such a task, however, the application of IAT to the realm of the complex human communicative interactions presents some initial challenges and the theory needs to be adapted so that it is robust enough to describe how people create arguments during the dialogue.

We selected the genre of the radio debate and worked with the BBC Radio Moral Maze programme (the corpus is available at: <http://corpora.aifdb.org/>, see also Sect. 5). During each 45 minute programme, participants discuss moral aspects of important social and political issues in Great Britain. The programme is chaired by Michael Buerk who leads the discussion between four panellists – public people with a background in social activism (writers, journalists, lecturers, public commentators etc.). Moreover, so-called witnesses are invited who are experts on a given topic and who describe a situation in more detail. Such structured radio debate ensures that participants create many well-formed arguments which can be studied.

Consider the example from the programme on problems of families where the participants discuss whether or not the State should intervene into the problem families in order to decrease the poverty in the country. Here Anne and Ruth were trying to establish whether a number of families who might need an intervention is sufficient for making a moral issue about this. Ruth provides the percentage of badly

parented children (according to the Government's criteria) in the troubled families of different boroughs of London.

- (2) a. Anne McElvoy: Isn't it a rather specific example?
- b. Ruth Levitas: No. Birmingham was given a target of 4180, they estimate they can find about 7% on the troubled families' criteria.

What we would like to capture here in this example is that Levitas introduces the conflict with McElvoy (argument con-) and provides an inference (argument pro-) to support her standpoint. Such a communication dynamic is relatively simple for a human to recognise, but it poses more difficulties for automatic identification of dialogical argumentation¹.

First, McElvoy's standpoint is not asserted explicitly qua an affirmative sentence but as an interrogative one. Yet questions do not aim to provide opinions – they are seeking for them, so the problem is: how Levitas can introduce the conflict if there was no opinion provided in (2-a)? For example, if I say “Do you like apples?”, I am not giving my opinion with which the hearer can conflict. I rather want the hearer to provide me with her opinion in the matter that I am asking about. Thus, developing an algorithm which associate a sequence: a question followed by an answer “No”, with a conflict structure is not a good solution, because the automatic system would deliver a lot of errors as an output. We need to look for a more fine-grained theoretical grounding here.

A second challenge is related to indexicality which is particularly common in dialogical communication, because people typically do not repeat a material that was already introduced by their opponents in the previous move(s). Imagine I enter the room exactly when Levitas begins her turn. Without knowing what happened before (2-b), it is impossible to reconstruct the propositional content of her first locution. In other words, if I just hear that someone says “No”, it is not possible to understand whether she meant “It is not a rather specific example”, “I don't like apples” or anything else. From the point of view of the automatic recognition, we need a good way of instructing an algorithm where to look for the content in such cases and how to extract it².

¹ We assume that dialogical argumentation (or: quasi-dialogical argumentation) does not necessarily require two or more speakers. It is sufficient for one speaker to introduce quasi-dialogue, when he cites or refers to opinions of his opponent(s). In such cases, the speaker can provide con-arguments against his opponent(s)' standpoints, and justify his own opinions with pro-arguments.

² Note that the indexicality is not a specific property of argumentation -- in fact it occurs in any natural communication. Nevertheless, while it is rather rarely found in monological argumentation, it becomes an important part of dialogical argumentation.

The first challenge was addressed by extending the list of the illocutionary connections with such ones that are typical for dialogical interactions. In the example (2), such a specific connection is assertive questioning which has a dual function of both asserting and questioning (see Budzynska et al. 2014b for other dialogical connections). More specifically, in (2-a) McElvoy does not only seek Levitas' opinion whether it was a rather specific example, but also implicitly conveys her own opinion that it was a rather specific example (see figure 2). In contrast to a pure question which only seeks for the hearer's standpoint, here the speaker (McElvoy) gives her own opinion, and as a result when the hearer (Levitas) responds to such an assertive question, the respondent (Levitas) provides her opinion as well, and as a result she either agrees or disagrees with the previous speaker (in this case – Levitas disagrees with McElvoy introducing conflict between their opinions).

The second challenge, the challenge of indexicality, is addressed by anchoring illocutionary connections in transitions. In figure 2, there are three such cases: disagreeing, asserting and arguing. If annotators analyse the example (2) as it is presented in figure 2 and the data is used to develop an algorithm, then the instruction specifies that it is not enough to look at the single locution ("RL: No" in figure 2) to extract the content of Levitas' assertion, because the asserting connection is not anchored in the locution. What is required is to find the transition, check which locutions is connected ("AM: Isn't it a rather specific example?" with "RL: No"), and then it is possible to recognise what is the propositional content of the second locution. In other words, if Levitas started her turn in (2-b) by saying "It is not a rather specific example" (the response which is fully repeating the content of the question), then the assertion would be anchored in the second locution and there would be no need to look at the history of this locution for the automatic extraction of its propositional content.

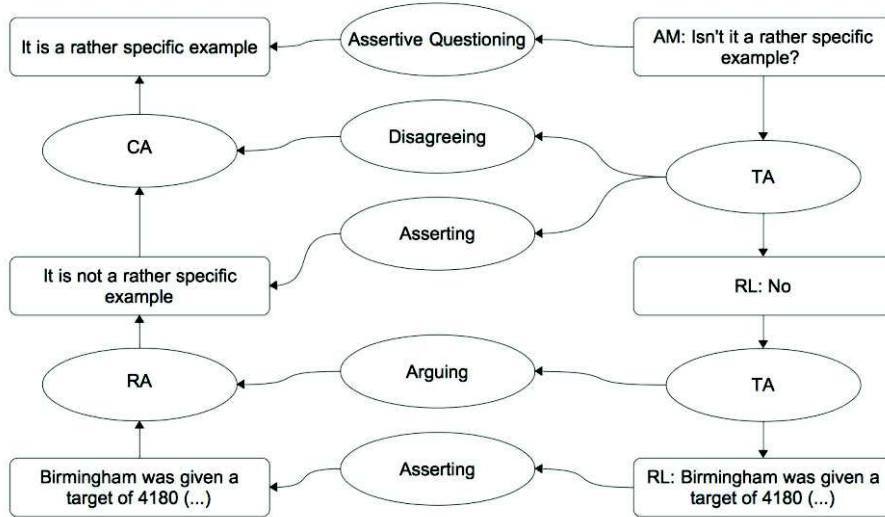


Figure 2. Disagreeing and arguing in a dialogical context.

How do these solutions lay foundations for automatically extracting inferential and conflict structures from transitions in a dialogue? We can instruct an algorithm that if it finds a sequence: pure question followed by a word that is equivalent to 'No', then there is no conflict introduced, while the conflict structure is created (see CA in figure 2), if the algorithm finds a sequence: assertive question followed by a word that is equivalent to 'No'. Moreover, since asserting is anchored in the transition between locutions and not in a single locution, in order to extract the content of "RL: No" the algorithm has to inspect the content of the other element of this transition relation.

To automatically recognise the inferential structure (see RA in figure 2), an algorithm has to be instructed that in this type of discourse a sequence: a word that is equivalent to "No" followed by assertion, anchors inference (in fact in many cases some additional cues are needed to increase the efficiency of the instruction). Moreover, the algorithm will extract directly the content of the premise, because the assertion introducing it is anchored in the single locution (see the bottom of the figure 2), however, in order to extract the full inferential structure (both premise and conclusion), it has to search for the transition and the second element of this relation (i.e. the locution "RL: No"). Still this locution does not anchor anything, so that the algorithm should not stop searching upwards into the history of the dialogue. Once it reaches the first locution, it can go back downwards which will allow for the reconstruction of the content of the second locution, which in turn will provide the information what is the conclusion of the inference.

4. RELATED WORK

Automatic argument mining has received a lot of interest during the past years and is now an important application of Computational Linguistics. This line of work started in specific domains, in particular that of legal language, where Mochales-Palau and Moens (2009) identified claims and their justifications in legal texts. Today, the task is sometimes conceived more broadly as finding not just pairs of claim and argument, but more complex structures involving rebuttals, counterrebuttals, etc.. Genres that are being studied include scientific papers (e.g., Kirschner et al. 2015) and student essays (e.g. Nguyen and Litman 2015). Beyond monologue text in “standard” language, lately the research also turned to more dialogical communication. Thus, the Internet Argument Corpus (Walker et al. 2012) is a collection of contributions to internet discussion forums, where users interact with each other to a certain extent. An example for analyzing such discourse automatically is the work on online user comments by Park et al. (2015). Snaith and Reed (this issue) propose the automatic method of inducing context-free grammar from a transcript of a dialogue. The extracted grammar describes the formal protocol that governs the interaction of this dialogue. Also, Swanson et al. (2015) propose an operationalization of the notion of „argument clarity“ for such comments, where sentences are being rated (via crowdsourcing) in terms of this clarity, and automatically identified on the basis of features that to a good extent are domain-neutral. For transcriptions of oral dialogue, however, we are not aware of any research other than our own.

Mining the structure of argument in text starts with segmentation, i.e., the step of finding the individual spans that correspond to the minimal segments of the argumentative structure. Thereafter, the two computational tasks to be executed on the basis of a text segmentation are (i) to identify the illocutionary connection of individual units, and (ii) to identify the relations between those units. For (i), certain linguistic features of the utterance (e.g., sentence mode, mood, modality, verb class, particles) and the context of recent moves are exploited to compute the most likely speech act. The computational dialogue analysis community has addressed this task for a long time, using both rule-based and statistical approaches; for the latter, see, e.g., (Stolcke et al 2000). Task (ii) is closely related to efforts in discourse parsing, which, again, usually targets monologue text. One popular framework is Rhetorical Structure Theory (Mann and Thompson 1988), which posits that a tree structure can be assigned to a text on the basis of recursively linking adjacent segments by means of coherence relations. One well-known approach to automatically compute these relations and the resulting tree structure is that of (Hernault et al. 2010), who divided the task into two

separate classifiers for (i) deciding whether to link two segments, and (ii) assigning a relation label to such pairs.

Beyond building a structure description, intellectual argument analysis involves judging the plausibility of instances of argumentation. This is largely beyond the state of the art of automatic analysis, but an important first step into this direction is the automatic classification of arguments in terms of Argumentation Schemes (Walton et al. 2008). Feng and Hirst (2011) showed that this is in principle possible, restricting the set of schemes to five frequently-used ones.

5. CORPUS DESCRIPTION

Within the corpus studies, 4 transcripts of the BBC 4 radio program *Moral Maze* were annotated (hereafter MM2012a) according to the IAT framework.³ MM2012a contains 58000 words and has 284 questions or challenges for about 1417 assertions which are parts of argumentation (from total of 2000 identified sentences). Analyses were carried out using OVA+⁴ (Janier et al. 2014) and stored in AIFdb corpus⁵ (Reed et al. 2008, Lawrence and Reed 2014). In the first step, dialogue moves were described with illocutionary connections, distribution of which is presented in table 1.

Annotating corpora is a time-consuming task (particularly with IAT because of the large variety of schemes and categories); moreover, the spoken interactions context makes the task trickier than with monologues, hence the relatively small size of our corpus.

³ Results provided here account for August, 2015; they may differ from previous works given that the corpus was enlarged to add a fourth transcript

⁴ <http://ova.arg-tech.org>

⁵ <http://corpora.aifdb.org>

Illocutionary connections	Occurrences
Assertions (A)	1417
Pure Questions (PQ)	81
Assertive Questions (AQ)	103
Rhetorical Questions (RQ)	70
Total Questions (Q)	254
Pure Challenges (PCh)	7
Assertive Challenges (ACh)	10
Rhetorical Challenges (RCh)	13
Total Challenges (Ch)	30
Popular concessions (PCn)	53
Other	7
Total Concessions	60
Empty (no illocutionary connection in locutions)	88
Total	1849

Table 1. The distribution of illocutionary connections anchored in locutions in MM2012a corpus.

Within 1849 annotated locutions, apart from the most expected illocutionary connections (Assertions: 1417 occurrences), there is also a significant number of illocutionary connections via which participants introduce premises and conclusions for their arguments (AQ, RQ, ACh, RCh, PCon and Con: 256 occurrences). This data illustrates the dynamics of radio debates via the variety of illocutionary connections.

In the next step of the corpus analyses, transitions between locutions were identified and illocutionary connections anchored in those transitions were described. The distribution of the identified illocutionary connections anchored in transitions is presented in table 2.

Illocutionary connections	Occurrences
Arguing	563
Disagreeing	200
Agreeing	101
Restating	78
Asserting	45
Questioning	2
Challenging	3
Other	80
Non-anchoring (no illocutionary connection in transition)	360
Total	1432

Table 2. The distribution of illocutionary connections anchored in transitions in MM2012a corpus.

Within 1432 of all analysed occurrences, 763 (61%) illocutionary connections anchored in transitions are related to the process of argument construction carried out via the illocutionary connections of arguing, disagreeing and agreeing, what illustrates that this type of dialogue is very argumentative. The dialogical dynamics proper to debates were thus identified: Arguing, Disagreeing and Agreeing. Occurrences of other types of argumentative dynamics being far less than 100 each, we decided to group them all together (Other).

The MM2012a corpus has been annotated by two annotators that have the same linguistic training and a good expertise of the IAT theoretical background. Measures of the differences between annotators, calculated before discussion, are summarised in table 3.

Types of annotation	Inter-annotator agreement
segmentation	79%
illocutionary connections (YA)	88%
illocutionary connections (YA) anchored in TA	78%
conflict relation (CA)	76%
inference relation (RA)	86%
transitions (TA)	89%

Table 3. Inter-annotator agreement measures for MM2012a corpus.

We measured the rate of agreement between the two annotators. All in all, the agreement rate is relatively high. For this reason, we

consider the framework schemes as stable, easy to identify and accurate. (see more about argument corpus studies with the use of IAT in: Janier and Yaskorska, 2015).

6. AN AUTOMATIC IDENTIFICATION OF ILLOCUTIONARY CONNECTIONS ANCHORED TO TRANSITIONS

Let us now develop the main features of a linguistic model and an implementation that allow to automatically identify illocutionary connections anchored to transitions. In this first experiment, three main illocutionary connections are considered: Disagreeing, Agreeing and Arguing. The other connections such as reframing or conceding are not considered here: they are relatively infrequent. It is interesting to see in this corpus that the level of disagreement is relatively high, this means that dialogues are rather controversial.

This first investigation is based on the linguistic cues found in the units at stake. It is clear that some cases need, in addition, context, knowledge and inference to be identified, however, linguistic analysis is favored because it is simpler, requires less resources and is relatively reusable, within similar dialogical contexts. Illocutionary connections anchored to transitions are identified on the basis of a pair, adjacent or not, of dialogue units, their contents and the illocutionary connection that is associated to each of them (see section above). It is clear also that in some cases, relatively limited, the taking into account of more than two units would introduce more contextual elements and would help to resolve ambiguities.

For this preliminary mode, our development corpus is composed of 248 already tagged transitions between units. This is not very large, but seems to be sufficient for our current aim. Transitions without any illocutionary connections are not considered in this investigation, they correspond to about 15 to 20% of the situations, and will be investigated in a later stage of the project.

Let us now develop the linguistic model elaborated for each of the illocutionary connections given above. Let us consider a pair of units (U1, U2) and the transition T that occur between them. U1 and U2 respectively have the illocutionary connections Uif1 and Uif2, while T is anchored the illocutionary connection Tif. The model that is developed below considers the linguistic contents of U1 and U2, Uif1 and Uif2 and the fact that these are uttered by the same speaker (S1) or by different speakers (S1 and S2). This analysis has obviously a relational character, between units and speakers.

Since our corpus is quite small, we have first identified linguistic marks, explaining why they contribute to disagreeing, agreeing or arguing and then we have slightly generalized them via synonyms or

equivalent expressions. Finally, these marks have been grammaticalized, when relevant, in order to avoid long lists of terms and to favor a “local” grammar approach that characterizes illocutionary connections anchored to transitions.

6.1 A model for Disagreeing

A first parameter to consider are **the illocutionary connections assigned to U1 and U2**. Some typical cases have been identified such as:

[U1: Assert] & [U2: Assertive Question] & [different speakers]
→ Disagreeing

Where Disagreeing is the illocutionary connection anchored to the transition T. Some typical language expressions may also be involved as constraints in order to confirm disagreement, since there are situations which may be ambiguous with other illocutionary connections.

A second situation is the case where U1 and U2 are uttered by two different speakers, or where there is a reported speech situation, usually in U1, and where **forms of negation** are observed in either U1 or U2. Roughly, these forms of negation indicate that the speakers do not share the same point of view. These forms of negation are quite numerous. Let us cite here the main categories:

- (1) Variants of negation: “*I do not*”, “*I don’t*”, “*I cannot*”, “*can never*”, etc. These forms are essentially observed contrastively in U2.
- (2) Negatively oriented propositional attitudes: “*I disagree*”, “*I cannot accept*”, etc.
- (3) Contrastive connectors between U1 and U2: *however*, *but*, etc.
- (4) Negatively oriented lexical terms: “*sluggish*”, “*bad*”, “*wrong*”, “*aberration*”, “*harmful*”, etc. associated with a judgement in U2 about a fact reported in U1.
- (5) Contextually negative terms: “*coercive*”, “*peculiar*”, “*warnings*”, “*dangerous*” found in U2 as a response to U1 and negative judgement terms: “*unwanted*”, “*undesired*”, “*hazardous*” in U2 when a fact or opinion is given in U1
- (6) Use of antonyms in U1 and U2, bipolar or continuous: “*expensive / cheap*”, “*moral / immoral*”, or the negation, in any order, e.g.: “*coercive / not coercive*”.

The last main situation to consider occurs when U1 and U2 are produced by the **same speaker**, with two situations:

- (a) the use of contrastive expression: P *but* Q or
- (b) a reported speech situation, citing someone else or an admitted opinion.

Our lexicon of negative terms contains about 100 terms, which is not very large. This indicates that speakers tend to use terms which can be understood by a large population of listeners. Each of the above situations is expressed by a “local” grammar and may be associated with constraints and restrictions.

6.2 A model for Agreeing

The linguistic model for Agreeing is based on the same philosophy, it may be slightly simpler. It is structured around two main situations:

The Illocutionary connections assigned to U1 and U2 may precisely characterize forms of agreement, e.g.:

[U1: Assert] & [U2: Assertive Question] & [same speaker for U1 and U2] → Agreeing

Typical forms of agreement in U2, with no negation in U1, often define forms of agreement. Among the most typical ones, let us cite:

- (1) Typical forms of approving: *yes, OK, I'm happy*, etc.
- (2) Forms expressing an opinion that approves U1 contents: *I think, they are right, I agree, I like*, etc.
- (3) Typical positive expressions, positive evaluative expressions: *sympathetic, interesting, powerful point*, etc.
- (4) Typical positive binders between U1 and U2: *as you say, your own experience, well* not followed by any negative expression, etc.

These forms of agreement are more or less strong (e.g. *I do not disagree* is less strong than *I agree*). Measuring these connections is beyond the present investigation since these are relative to the speaker and to the situation. It is interesting to note that language seems to be richer in negative terms than in positive ones. Our lexicon of positively oriented terms contains at the moment about 60 terms.

6.3 A model for Arguing

Arguing is by large the main situation (70% of the cases in our development corpus, but this may vary from dialogue to dialogue). Arguing can occur between two speakers or a given speaker may be arguing for his/her own views.

In our analysis, Arguing is considered as the by-default option: if no Disagreeing or Agreeing situation has been detected, then by default it is an Arguing illocutionary connection.

However, to confirm our analysis, a few linguistic cues have been identified, which may be used when there are ambiguities with agreeing or disagreeing. These mainly are:

- (1) Unit discourse connectors: *but also, if you, indeed, so* (with some constraints), etc.
- (2) Connectors such as *but* or *however* introducing U2, without any negative expression in U2.

6.4 Implementation and performances

This relatively simple linguistic model has been implemented on our TextCoop platform using discourse patterns and constraints. The results obtained are reported in table 4, expressed in terms of accuracy (we consider our evaluation as indicative, therefore tests involving precision and recall are not yet relevant):

Illocutionary connection	Correctly recognized	Not correctly recognized
Disagreeing	82%	18%
Agreeing	85%	10%
Arguing	95%	5%

Table 4. Performance results of automated extraction of illocutionary connections.

Results are good in spite of the relative simplicity of the analysis and the complexity of the task. One of the reasons is that speakers of the Moral Maze make their best to use a clear language, well-structured with explicit marks so that they position and argumentation is clear and unambiguous. Results could be different if one considers less controlled dialogues.

An important remark concerns the errors: among the ‘not correctly recognized’ connections, only about 1/3 of them are due to an incomplete or incorrect linguistic analysis or to language ambiguities, while the other 2/3 would require knowledge and inference to identify the illocutionary connection anchored to the transition. This would be an interesting research direction: the pragmatic forms of disagreement or agreement. In a number of situations, domain knowledge can help identify the correct connection, but this is much more costly in terms of resources than just using linguistic knowledge.

This section has presented a preliminary linguistic and language processing analysis of illocutionary connections anchored to transitions, in addition to the works done on unit delimitation and their illocutionary connection identification, presented above. This work remains largely exploratory and is still preliminary. Results show that linguistic analysis is worth pursuing but that a relatively large number of cases (about 15%) need pragmatic analysis which is not surprising, even in well-formed dialogues. This rate should be higher in less controlled ones.

7. CONCLUSION

This paper has reported on the first few steps of a new methodology for understanding argument structure in dialogue that is predicated on the constraints imposed on interaction by tacit common understanding of the dialogue game that is being played. The work has demonstrated that even quite simple rules of these games – rules that describe some of the ways in which speakers can disagree, agree and argue – can constrain expressions sufficiently to be able to contribute significantly to the extremely demanding AI task of automatically recognising argument structure in free natural language. Though this paper reports early advances, it demonstrates that the approach represents a rich seam of academic investigation.

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